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Electron capture and ionization processes in high velocity C_n^+, C-Ar and C_n^+, C-He collisions.

G.Labaigt[#], A.Jorge[¤], C.Illescas[¤], K. Béroff[*,1], A.Dubois[#,2], B.Pons[§,3], M.Chabot[†]

[#] Laboratoire de Chimie Physique-Matière et Rayonnement, Université Paris 06 and CNRS F-75231 Paris, France
[¤] Departamento de Qimica, Modulo 13, Universidad Autonoma de Madrid, 28049 Madrid, Spain
[*] Institut des Sciences Moléculaires d'Orsay, Université Paris Sud and CNRS F-91405 Orsay Cedex, France
[§] CELIA, Université de Bordeaux - CEA - CNRS, 33405 Talence, France
[†] Institut de Physique Nucléaire d'Orsay, Université Paris Sud and CNRS F-91406 Orsay Cedex, France

Synopsis: Single and double electron capture as well as projectile single and multiple ionization processes occurring in 125keV/u C_n^+-He, Ar collisions have been studied experimentally and theoretically for $1 \leq n \leq 5$. The Independent atom and electron (IAE) model has been used to describe the cluster-atom collision. The ion/atom-atom probabilities required for the IAE simulations have been determined by classical trajectory Monte Carlo (CTMC) and semiclassical atomic orbital close coupling (SCAOCC) calculations for the Ar and He targets respectively. In general the agreement between experiment and IAE simulations was good, with the exception of double electron capture leading to anionic C_n^- species.

Experiments have been performed at the Tandem accelerator in Orsay (France), using the AGAT setup [1], to study electron capture and ionization processes in carbon cluster –He, Ar collisions at high impact velocity. Single and double electron capture as well as projectile single and multiple ionization processes have been investigated in 125keV/u C_n^+-Ar, He collisions. Helium single and double ionization cross sections have also been measured in the 100-400 keV/u range (n=1,4). The present work extends and improves a recent study devoted to single and double electron capture in C_n^+-He collisions [1]. Indeed, in addition to the study of new processes and consideration of another target atom, we performed state of the art calculations of impact parameter probabilities for all the processes, in particular for electron capture by neutral C atoms that was fitted on the experiment previously. Also, the role of electronic correlations has been investigated within the SCAOCC approach by performing calculations with one, two or three active electrons [2].

We found a general good agreement between measured and IAE cross sections. For projectile ionization, IAE predictions are in very good agreement with experiment in C_n^+-He collisions, whereas IAE predicts right order of magnitude for the cross sections in C_n^+-Ar systems, in particular the large multiple-ionization cross sections. For neutralization of C_n^+, the agreement is better in the helium target case than in the argon target case. Due to the role of projectile ionization, IAE predicts cross sections smaller with argon than with helium, in accordance with the experiment. For He target ionization in C_n^+-He collisions the agreement is satisfactory which allows to extend the applicability of the IAE model, previously tested on projectile ionization and electron capture, to this process as well.

In contrast with the above cited processes, IAE predictions strongly overestimate double electron capture leading to anionic C_n^- species. This was already observed in the case of the helium target [1] and confirmed here in the argon target case [2]. We suspect the loss of the loosely bound electron to lie at the origin of the discrepancy. Indeed, for anions, electron emission is a probable relaxation channel, which is not measured in the present experiment and which deserves further investigation.

References

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[1]E-mail: karine.beroff@u-psud.fr
[2]E-mail: alain.dubois@upmc.fr
[3]E-mail: pons@celia.u-bordeaux1.fr